AMENDMENT TO THE CLAIMS

1. (Currently Amended) A soft decision decoder comprising:

a ~~plurality of log likelihood ratio calculators~~first log likelihood ratio calculator and a second log likelihood ratio calculator, for using a receive signal y with noise input from a receiver so as to perform soft decision decoding on a QAM (quadrature amplitude modulation) signal, the first log likelihood ratio calculator and the second log likelihood ratio calculator ~~reflecting~~ incorporating ~~of~~ channel estimation errors in ~~, and~~ calculating ~~of~~ a log likelihood ratio of a positive ~~number~~ signal (x^+) and a negative ~~number~~signal (x^-), respectively;

a subtractor for determining a difference between ~~the positive signal and the negative signal~~ outputs ~~by~~ of the log likelihood ratio calculators; and

a comparator for receiving a calculation result on the difference of the log likelihood ratios of the subtractor, and determining the QAM signal to be positive or negative according to a positive/negative state of the calculation result.

2. (Currently Amended) The soft decision decoder of claim 1, wherein each of the log likelihood ratio calculators comprises:

M multipliers for receiving a channel estimate $\hat{a}$ estimated by the receiver, and receiving M reference signals x_i from a transmitter to respectively multiply them;

M subtractors for receiving M multiplication values multiplied by the multipliers to subtract them from ~~a~~ the receive signal y received from the receiver;

M first square calculators for respectively squaring M subtraction values subtracted by the subtractors;

M second square calculators for receiving the reference signals x_i to respectively square them;

M adders for respectively adding M square values of the reference signals input by the second square calculators and a ratio ρ of a symbol noise bandwidth of a QAM signal and a channel estimation filter noise bandwidth;

M dividers for dividing M square values input by the first square calculators by the M addition values input by the adders ~~122~~; and

a comparator for selecting the minimum value from among the M division values input

by the dividers~~123~~, and outputting a log likelihood ratio.

3. (Currently Amended) A log likelihood ratio calculator for soft decision decoding, comprising:

M multipliers for receiving a channel estimation value $\hat{a}$ estimated by the receiver, and receiving M reference signals x_i from a transmitter to respectively multiply them;

M subtractors for receiving M multiplication values multiplied by the multipliers to subtract them from a receive signal y received from the receiver;

M first square calculators for respectively squaring M subtraction values subtracted by the subtractors;

M second square calculators for receiving the reference signals x_i to respectively square them;

M adders for respectively adding M square values of the reference signals input by the second square calculators and a ratio ρ of a symbol noise bandwidth of a QAM signal and a channel estimation filter noise bandwidth;

M dividers for dividing M square values input by the first square calculators by the M addition values input by the adders~~122~~; and

a comparator for selecting the minimum value from among the M division values input by the dividers~~123~~, and outputting a log likelihood ratio for soft decision decoding in consideration of channel estimation errors.

4. (Original) The log likelihood ratio calculator of claim 3, wherein the log likelihood ratio output by the comparator is given as follows:

$$\tilde{\gamma}(c_i) \approx \ln \frac{\max_{x^+ \in \{x: c_i = +1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^+|^2}{|x^+|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}}{\max_{x^- \in \{x: c_i = -1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^-|^2}{|x^-|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}} \gtrless 1$$

$$= \max_{x^+ \in \{x c_i = +1\}} \left\{ - \frac{|y - \hat{a}x^+|^2}{(|x^+|^2 + \rho)\sigma_e^2} \right\} - \max_{x^- \in \{x c_i = -1\}} \left\{ - \frac{|y - \hat{a}x^-|^2}{(|x^-|^2 + \rho)\sigma_e^2} \right\} \gtrless 0$$

$$= \min_{x^- \in \{x c_i = -1\}} \left\{ \frac{|y - \hat{a}x^-|^2}{|x^-|^2 + \rho} \right\} - \min_{x^+ \in \{x c_i = +1\}} \left\{ \frac{|y - \hat{a}x^+|^2}{|x^+|^2 + \rho} \right\} \underset{-1}{\overset{+1}{\gtrless}} 0$$

where $\rho = \frac{\sigma_n^2}{\sigma_e^2} = \frac{BW_n}{BW_e}$, BW_n is a QAM signal symbol noise bandwidth, and BW_e is a channel estimation filter noise bandwidth.

5. (Original) A method for calculating a log likelihood ratio for soft decision decoding, comprising:

(a) receiving a channel estimation value $\hat{a}$ estimated by a receiver, receiving M reference signals x_i from a transmitter to respectively multiply them, and receiving multiplication values to subtract them from a receive signal y received from the receiver;

(b) respectively squaring subtraction values and the reference signals x_i in (a);

(c) respectively adding square values of the reference signals input in (b) and a ratio ρ of a symbol noise bandwidth of a QAM signal and a channel estimation filter noise bandwidth;

(d) dividing square values of the subtraction values input in (b) by the addition values added in (c); and

(e) selecting the minimum value from among the values input in (d), and outputting a log likelihood ratio for soft decision decoding in consideration of channel estimation errors.

6. (Original) The method of claim 5, wherein outputting a log likelihood ratio in (e) follows

the subsequent equation.

$$\tilde{\gamma}(c_i) \approx \ln \frac{\max\limits_{x^+ \in \{x : c_i = +1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^+|^2}{|x^+|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}}{\max\limits_{x^- \in \{x : c_i = -1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^-|^2}{|x^-|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}} \gtrless 1$$

$$= \max_{x^+ \in \{x c_i = +1\}} \left\{ - \frac{|y - \hat{a}x^+|^2}{(|x^+|^2 + \rho)\sigma_e^2} \right\} - \max_{x^- \in \{x c_i = -1\}} \left\{ - \frac{|y - \hat{a}x^-|^2}{(|x^-|^2 + \rho)\sigma_e^2} \right\} \gtrless 0$$

$$= \min_{x^- \in \{x c_i = -1\}} \left\{ \frac{|y - \hat{a}x^-|^2}{|x^-|^2 + \rho} \right\} - \min_{x^+ \in \{x c_i = +1\}} \left\{ \frac{|y - \hat{a}x^+|^2}{|x^+|^2 + \rho} \right\} \underset{-1}{\overset{+1}{\gtrless}} 0$$

where $\rho = \frac{\sigma_n^2}{\sigma_e^2} = \frac{BW_n}{BW_e}$, BW_n is a QAM signal symbol noise bandwidth, and BW_e is a channel estimation filter noise bandwidth.